CONSTRUCTION OF A PEDAL OPERATED SCROLL SAW

A Thesis

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SONARGAON UNIVERSITY (SU)

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In partial fulfillment of the requirement for the award of the degree of

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

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LETTER OF TRANSMITTAL

January 2024
To
Md. Mahfujul Islam
Lecturer
Department of Mechanical Engineering
Sonargaon University (SU)

Subject: Submission of Project Report.

Dear Sir,

We pleased to submit the project report on" **Construction of a pedal operated scroll saw**". It was a great pleasure to work on such an important topic. This project has been done as per instruction of your supervision and according to the requirements of the **Sonargaon University.**

We expect that the project will be accepted by the concerned authority we will remain happy to further explanation that you may feel necessary in this regard.

Thank You

Sincerely yours

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DECLARETION

We hereby, declare that the work presented in this project is the outcome of the investigation and research work performed by us under the supervisor of **MD. Mahfujul Islam, Lecturer, Department of Mechanical Engineering, Sonargoan University (SU).** We also declare that no part of this project and thereof has been or is being submitted elsewhere for the award of any degree.

…….

MD. Mahfujul Islam

Lecturer Department of Mechanical Engineering

Sonargoan University (SU).

ACKNOWLEDGEMENT

First, we started in the name of almighty Allah. This thesis is accomplished under the supervision of **Md. Mahfujul Islam**, Lecturer, Department of Mechanical, Sonargaon University. It is a great pleasure to acknowledge our profound gratitude and respect to our supervisor for this consistent guidance, encouragement, helpful suggestion, constructive criticism and endless patience through the progress of the work. The successful completion of this thesis would not have been possible without his persistent motivation and continuous guidance.

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"The Authors"

ABSTRACT

A scroll saw is a small electric or pedal-operated saw used to cut intricate curves in wood, metal, or other materials. The fineness of its blade allows it to cut more delicately than a power jigsaw, and more easily than a hand coping saw or fretsaw. Like those tools, it is capable of creating curves with edges, by pivoting its table. The scroll saw\'s name derives from its traditional use in making scrollwork, sculptural ornaments which prominently featured scroll-head designs a bevel scale is located under the saw table as a convenient guide for setting the approximate saw table angle for bevel cutting. When greater precision is required, make practice cuts on scrap material and adjust the saw table as necessary. When cutting at an angle, the drop foot should also be tilted so that it is parallel to the saw table and rests flat against the work piece. To tilt the drop foot when making a bevel scroll saw cut, loosen the Phillips screw, tilt drop foot to the proper angle and then retighten screw. Blade tension knob: Check tension by the sound the blade makes when plucked like a guitar string. This method of adding tension to the blade can be developed with practice and requires knowing a better understanding of your particular scroll saw. Be careful not to adjust blade too tight. [4]

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CHAPTER 01
INTRODUCTION

1.1. INTRODUCTION:

A scroll saw is a small pedal-operated saw, which are used to cut intricate curves in wood, or other materials. The fineness of its blade allows it to cut more delicately than a power jigsaw, and more easily than a hand coping saw or fretsaw. Like those tools, it is capable of creating curves with edges,[clarification needed] by pivoting its table .The scroll saw's name derives from its traditional use in making scrollwork, sculptural ornaments which prominently featured scroll-head. Positive space is where the wood is still intact and negative space is where the wood has been removed. The bridges are the positive spaces on the wood that connect the different parts. Stick to a simple design if you are just beginning to use a scroll saw. For example, practice making a leaf or a flower first, with only a few areas of negative space. There are several types of scroll saws. The most common design is the parallel arm, in which a motor is attached near the back of the arms and the two arms always remain parallel to each other. The C-arm variant uses a solid "C" shaped arm, with the blade being mounted between the two ends of the "C". The parallel link type, used by Hawk, Excalibur, and dealt, has rods in the upper and lower arms that are "pushed" by the motor to move short (about 4 inches, or 100 millimeters) articulated arms which hold the blade, In this fabrication project is portable table Saw mainly used wood cutting operation, thin sheet metal, aluminum and brass. Industries are used big size and large amount of power is required. Accuracy we are used a stainless steel saw blade. [7]

1.2 Problem Statement

Pedal hacksaw are used in mechanical and allied industries which cuts pipe made of different materials. The Pedal hacksaw machine is widely used in piping industries or in Scrap dealers’

Shop to reduce the volume of the storage. Consequently, it leads to the reduction of the transportation cost. This machine is primarily used to save space and for cutting. Incan be placed anywhere.

1.3 The main objectives of the project:

- The main objectives of the project are-
- *To gain Knowledge about various mechanical instruments related to this project.
- To construct a pedal operated Scroll Saw.
- To compare the output speed obtained from this scroll saw with generalized value.
- To reduce the efforts.

CHAPTER 02

LITERATURE REVIEW

1) B.P.Numbi, X.Xia and J. Zhang, have presented an optimization technique for the vertical Pedal hacksaw. The paper presents the optimal control model to improve the operation efficiency of a vertical shaft impact Pedal hacksaw. They have proposed optimum methods to reduce the power consumption by varying the conveyor feed flow rate, the vertical shaft impact crusher rotor feed rate and the bi-flow or cascade flow rate.

2) Department of Design and Technology, Loughborough University, has presented a paper emphasizing the need for recycling the wastes particularly the metal can wastes. The paper insists that the requirement for environment accountability has become a feature of consideration for the engineers, especially for mechanical engineers. The various design methodologies have been discussed in the paper forth construction of a Pedal hacksaw which would be helpful in waste management.

3) M.Lindqvist and C.M.Evertsson, Department of Applied Mechanics Chalmers University Of Technology[24], Sweden have presented a paper to develop a wear model for the cone crushers which are used to crush the rocks minerals which are in the form of ores in mines. Disagreements between predicted and measured geometry and several effects were suggested to explain the discrepancy in the model. The models of complex construction and it has some of the real time shortcomings which reduces the efficiency of the machine drastically. The various drawbacks have been studied and the measurements have been done to predict the efficiency.

4) ZHAO La-la, WANG Zhong-bin and ZANG FENG of China University of Mining And Technology[25], have presented a paper on the Multi-object Optimization design for differential and grading toothed roll crusher using genetic algorithm. The Pedal hacksaw blends the efficiencies of toothed roll crusher and also the jaw crusher to possess great Pedal hacksaw ability and high breaking efficiency. Crank rocker mechanism forms the basis of the machine. Thus the construction of the machine becomes complicated and as a result the cost of the machine increases.

5) OLALEYE BM Department Of Mining Engineering, Federal University Of Technology, Nigeria, has proposed a paper on Jaw Crusher performance in the granite quarry. The paper determines the Effect of Rock Strength on Crushing Time and Grain Size Distribution of the rocks. Investigation was conducted with five sample rocks and the performance and drawbacks were spotted out. Various tests have been performed and the results have been tabulated and plotted in the form of graphs. [5]

Chapter – 03

Methodology

The scroll saw holds extremely fine blades under tension, allowing it to do jobs that no other motorized saw can do. Unfortunately, many woodworkers think that a scroll saw is only for hobbyists who make fretwork, bookends, whirligigs, and knickknacks. As a professional furniture maker, I've found the machine much more useful than that, and I believe it makes a valuable addition to any woodworking shop.

3.1 3D drawing of Scroll saw:

Fig 3.1 Pedal operated Scroll saw

3.2 Sprocket:

A sprocket, sprocket-wheel or chain wheel is a profiled wheel with teeth that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which radial projections engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth except for timing pulleys used with toothed belts.

Sprockets are used in bicycles, motorcycles, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles

Sprockets are of various designs, a maximum of efficiency being claimed for each by its originator. Sprockets typically do not have a flange. Some sprockets used with timing belts have flanges to keep the timing belt centered. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed. [1]

Fig 3.2 Sprocket [2]

3.3 Chain:

Chain drive, also known as a chain drive mechanism, is a way to transfer mechanical chain power from one place to another. Chain transmission is widely used in vehicles such as bicycles and motorcycles to transfer power to the wheels. It is also used in different types of machines. Most often, power is communicated by a roller chain, known as a drive chain or transmission chain that passes over a sprocket gear, with the gear teeth intersecting holes in the chain's links.

The gear is rotated, and this pulls the chain, exerting mechanical force in the mechanism. [3]

Fig 3.3 Chain [6]

3.4 Belt:

A **belt** is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel.

In a two-pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). The belt drive can also be used to change the speed of rotation, either up or down, by using different sized pulleys.

As a source of motion, a conveyor belt is one application where the belt is adapted to carry a load continuously between two points.

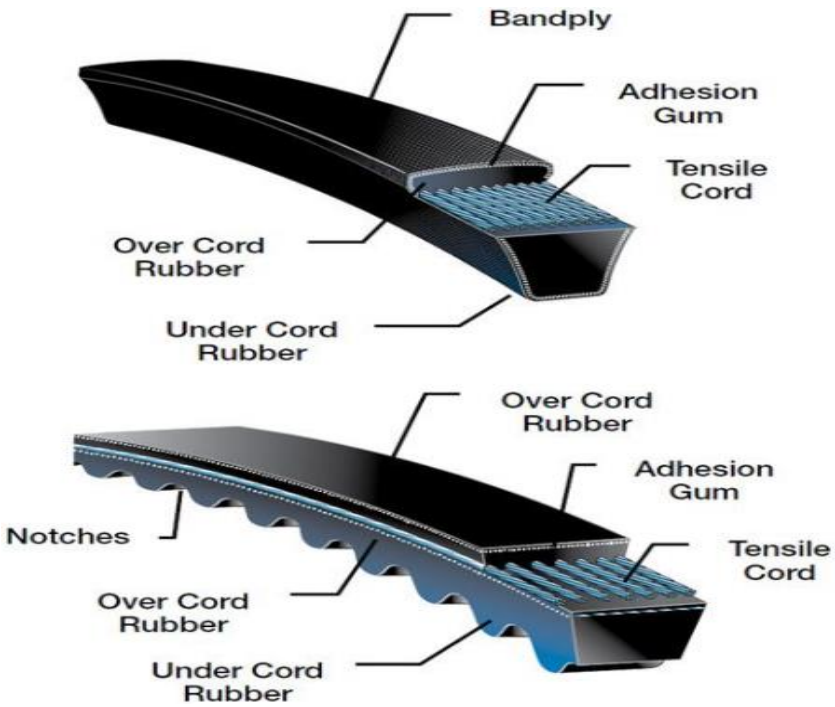

Fig 3.4 Belt

3.5 Pulley:

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt, or transfer of power between the shaft and the cable or belt. In case of a pulley supported by a frame or shell that does not transfer power to a shaft, but is used to guide the cable or exert a force, the supporting shell is called a block, and the pulley may be called a sheave or pulley wheel.

A pulley may have a groove or grooves between flanges around its circumference to locate the cable or belt. The drive element of a pulley system can be a rope, cable, belt, or chain.

Fig 3.5 Pulley

Driver Pulley

A drive pulley is a pulley that is attached to a power source, that when in use puts force on a belt (or cable or chain). The belt is connected to the object being driven, which will then spin. This is a type of power transmission. [8]

Driven Pulley:

Hence pulley that connects to the motor is termed as the driving pulley and the pulley which is connected to a belt and driven by moving belt drive is termed as the driven pulley. [10]

Fig 3.5.1 Driver & Driven Pulley [9]

3.6 Shaft:

The machine shaft is a critical component that serves as the central axis of rotation within a mechanical system. Its precise design and construction are paramount for ensuring the smooth and efficient operation of the entire machine. The material selection for the shaft is crucial, considering factors such as strength, durability, and resistance to wear. Accurate machining processes are employed to create a shaft with tight tolerances, minimizing vibrations and ensuring proper alignment with other machine elements. Regular maintenance and lubrication of the machine shaft are essential to prolong its lifespan and maintain optimal performance.

In mechanical engineering, a shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. [11]

Fig 3.6 Shaft [12]

3.7 Bearing:

Ball bearings are essential components in machinery, designed to facilitate smooth and efficient rotation by reducing friction. These bearings consist of small, spherical balls housed within a ring, allowing for easy movement and load distribution. The selection of materials for ball bearings is crucial, with common choices including steel and ceramic, depending on factors such as load capacity and operating conditions. Precision manufacturing processes are employed to achieve uniform size and shape of the balls, contributing to the overall reliability of the bearing.

Regular lubrication is vital to minimize wear and extend the lifespan of ball bearings, ensuring their continued contribution to the seamless operation of various mechanical systems. [13]

Fig 3.7 Bearing

3.8 Bearing Block:

Bearings are crucial components in various mechanical systems, serving to reduce friction and facilitate smooth rotation between two moving parts. They come in various types, including ball bearings and roller bearings, each designed for specific applications. Bearings are commonly found in machinery such as automobiles, industrial equipment, and household appliances. Proper lubrication is essential to ensure the longevity and efficiency of bearings by minimizing wear and heat generation. Regular maintenance and monitoring are necessary to detect any signs of wear or failure, preventing potential damage to the machinery they support.

The two most common bearing block types are pillow blocks and flange blocks. The main difference between the two is the orientation of the shaft to the mounting surface. [14]

Fig 3.8 Bearing Block [15]

3.9 Scroll saw Blade:

A scroll saw blade is a crucial component in the functionality of a scroll saw, a specialized tool used for intricate and detailed woodworking. These blades are thin and come in various types, each designed for specific cutting applications. The teeth of a scroll saw blade are arranged in a way that allows for precise and intricate cuts, making it suitable for intricate curves and patterns.

Choosing the right blade is essential for achieving different results, with options ranging from fine blades for delicate work to coarser blades for faster cuts in thicker materials. Regular maintenance and replacement of scroll saw blades are necessary to ensure optimal performance and the production of finely detailed woodworking projects.

The most common type of blade is the plain-end blade, which is available in a range of sizes from 3/0 to 20. These blades are used for general purpose Scroll sawing and are the best choice for beginners. [16]

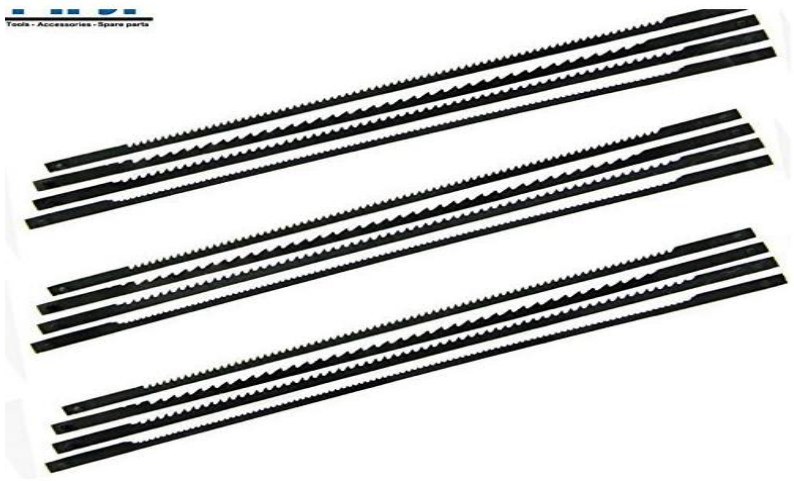

Fig 3.9 Scroll saw Blade

3.10 Scroll saw blade tensioner:

The scroll saw blade tensioner is a critical component in a scroll saw, playing a key role in ensuring the proper performance of the tool. It is responsible for controlling the tightness or tension of the blade, influencing the precision and quality of cuts. Adjusting the tensioner allows woodworkers to optimize the blade's performance based on the type of material being cut and the intricacy of the design. A well-adjusted tensioner ensures the blade remains stable during operation, reducing the likelihood of blade deflection and enhancing cutting accuracy. Regularly checking and adjusting the scroll saw blade tensioner is essential for achieving optimal results and maintaining the longevity of the blade.

A Scroll saw blade tensioner is typically used for precision cutting so is used almost exclusively with wood both softwoods and hardwoods. They are often used by carpenters and furniture makers to make short, accurate cuts. [17]

Fig 3.10 Scroll saw blade tensioner [18]

CHAPTER 04

Working principle

It consists of the pedal arrangement which rotates the larger sprocket in which the power is transmitted to the smaller sprocket. This mechanism is used to rotate the shaft connected to the smaller sprocket which is having an extended rod connected to the circular saw directly by means of a bearing support. The circular saw is mounted on the shaft by means of maintaining the cutting axis. As the user operated the pedal, the circular saw cuts the various materials automatically with less power. This project consists of a larger sprocket which rotates with a help of human powered pedal. The smaller sprocket is connected to the plane which is mutually perpendicular to the axis of the larger sprocket is made rotated by using chain drive. The smaller sprocket is rigidly supported by means of shaft and bearing support. The circular saw is mounted on the same shaft where the smaller sprocket is mounted. When the pedal is operated, circular saw rotated which in turn cuts the wooden block and Poly Vinyl Chloride material. The main aim is to reduce the human effort for machining various materials such as wooden blocks and Poly Vinyl Chloride etc. The power circular saw machine which runs on human power, works on the principle of the conversion of rotational motion in a mutually perpendicular axis. Importance of this project lies in the very fact that it is green project and helps us to reduce our electricity need too. Secondly, this cutter can be used and transferred to our working place easily. Moreover, if needed we can generate electricity with our project by connecting it to dynamo, diode and battery.

This machine uses a reciprocating action. The scroll saw cuts on the down stroke of the blade. It is a stationary machine and should be attached to a bench or a stand. Scroll saws can have a variable speed system or a two speed system. [19]

CHAPTER 05

Models

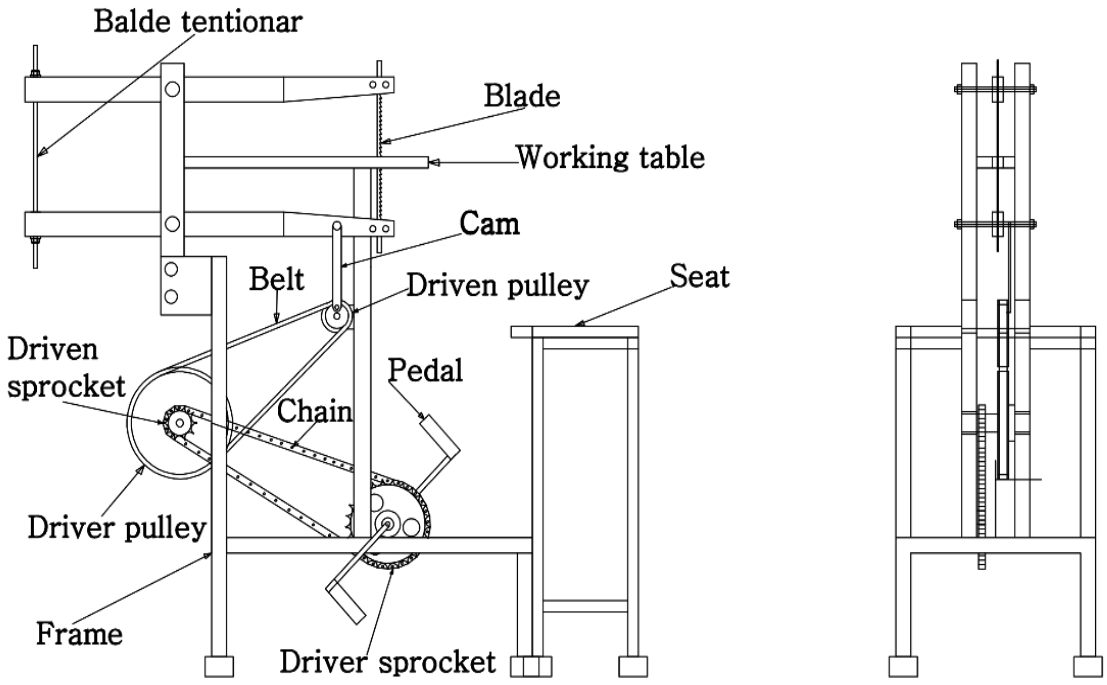

Fig: Pedal Operated Scroll Saw

CHAPTER – 06

Chain -Sprocket

6.1 Chain -Sprocket:

Designing a pedal-powered scroll saw involves several considerations, and while a complete and detailed calculation would require specific dimensions and material properties, here is a general outline of the key design considerations.

6.2 Pedal Mechanism:

Calculate the pedal mechanism, considering the length of the pedal arm and the placement of the pivot point. Ensure that the pedal motion provides sufficient force to drive the saw blade through the material. Consider ergonomics to ensure comfortable and efficient pedaling. [20]

6.3 Transmission System:

Determine the type of transmission system to convert pedal motion into the desired blade movement. Calculate gear ratios to achieve an appropriate speed for the scroll saw blade. Choose suitable materials for gears and other transmission components. [21]

6.4 Blade Mechanism:

Calculate the size and specifications of the scroll saw blade, considering the materials to be cut and the intricacy of the work. Ensure proper tensioning of the blade to prevent deflection during operation.

6.5 Frame and Structure:

Design a sturdy frame to support the pedal mechanism, transmission system, and the sawing platform. Calculate the dimensions and select materials for the frame to ensure stability and durability.

6.6 Material Selection:

Choose appropriate materials for various components, considering factors such as strength, weight, and cost. Calculate stress and strain on critical components to ensure they can withstand the forces applied during operation.

Safety Consideration incorporate safety features such as blade guards and emergency stops in the design.
Calculate forces and stresses to ensure that the pedal-powered scroll saw operates safely. [22]

6.7 Efficiency and Optimization:

Optimize the design for efficiency in power transmission to maximize the cutting performance. Consider factors such as friction and mechanical losses in the transmission system.

6.8 Prototype and Testing:

Build a prototype based on the calculated design. Conduct testing to validate the design calculations and identify areas for improvement.

It's crucial to note that this is a simplified overview, and a thorough design would involve more detailed calculations, iterative prototyping, and testing to ensure the pedal-powered scroll saw meets performance and safety requirements. Additionally, consulting with experts in mechanical design and woodworking machinery is recommended for a comprehensive and successful design

CHAPTER – 07

SCROLL SAW SAFETY

- Read and understand all safety instructions and operating procedures throughout the manual.

- Do not operate the Scroll Saw until it is completely assembled and installed according to the instructions.

- Should any part of Scroll Saw be missing, damaged, or fail in any way, or any electrical component fail to perform properly, shut off the switch and remove the plug from the power supply outlet? Replace missing, damaged, or failed parts before resuming operation.

- If you are not thoroughly familiar with the operation of a Scroll Saw, obtain advice from your supervisor, instructor or other qualified person.

- Serious injury could occur if the tool tips over or you accidentally hit the cutting tool. Do not store anything above or near the tool.

- Avoid injury from unexpected saw movement. Place the saw on a firm level surface where the saw does not rock and bolt or clamp the saw to its support

- Your scroll saw must be securely fastened to a stand or workbench. If there is any tendency for the stand or workbench to move during operation, the stand or workbench MUST be fastened to the floor.

- This scroll saw is intended for indoor use only.

- Tension blade properly before starting the saw. Recheck and adjust tension as needed.

- Blade teeth must point downward toward the table.

- Table must be cleared of all debris before operating saw. Do not perform lay out, set up or assemble work on the table when the saw is in operation.

- To prevent injuries, avoid awkward hand or finger positions, where a sudden slip could cause a hand to move into the blade when operating the saw.

- Hold work piece firmly against the table top.

- Never cut material that is too small to be held safely.

- Do not use dull or bent blades.

- Turn the saw off and unplug the cord if the blade binds in the saw kerf while being backed out of the work piece, usually caused by sawdust clogging the kerf. If this happens, turn off the scroll saw and unplug the power cord. Wedge open the kerf and back the blade out of the work piece.

- Do not feed the material too fast while cutting. Only feed the work piece at the rate the saw will cut.

- Do not start the saw with work piece pressing against the blade. Slowly feed the work piece into the moving blade.

- When cutting a large work piece, make sure the material is supported at table height.

- Exercise caution when cutting work pieces that are round or irregularly shaped. Round items will roll and irregularly shaped work pieces can pinch the blade

- Always release blade tension before loosening the blade holder screw.

- Make certain table tilting lock is tightened before starting the machine.

- Check for damaged parts before each use. Check for alignment of moving parts, binding of moving parts, breakage of parts, mounting or any other conditions that may affect operation. Parts that are damaged should be properly repaired or replaced before using the tool.

- Think safety. [23]

CHAPTER 08

Calculation

8.1: Generalize by Internet:

- We get pedal stroke as a human (N1) - 25/min
- Dia of driver sprocket (D1)=200 mm
- Dia of driven sprocket (D2)= 80 mm
- Dia of driver pulley (D3)=350 mm
- Dia of driven pulley (D4)=75 mm
- Output Speed (N4) =?

We know,

$$\frac{D2}{D1} = \frac{N1}{N2}$$

$$\frac{80}{200} = \frac{25}{N2}$$

$$N2 = \frac{25 \times 200}{80}$$

$$= 62.5 \text{ rpm}$$

Here, N2=N3 = 62.5 rpm

Now, $\frac{D4}{D3} = \frac{N3}{N4}$

$$\frac{75}{350} = \frac{62.5}{N4}$$

$$N4 = \frac{62.5 \times 350}{75}$$

N4 = 291.67 rpm or 292 rpm

8.2: **Practically Tested on Project:**

We get pedal stroke (N1) = 40 / min

- Dia of driver sprocket (D1)=200 mm
- Dia of driven sprocket (D2)= 80 mm
- Dia of driver pulley (D3)=350 mm
- Dia of driven pulley (D4)=75 mm
- Output Speed (N4) =?

We know,

$\Rightarrow \frac{D2}{D1} = \frac{N1}{N2}$

$\frac{80}{200} = \frac{40}{N2}$

$\Rightarrow$ N2 = $\frac{40 \times 200}{80}$

N2 = 100 rpm

Here, N2=N3 = 100 rpm

Now $\frac{D4}{D3} = \frac{N3}{N4}$

$\Rightarrow \frac{75}{350} = \frac{100}{N4}$

N4 = $\frac{100 \times 350}{75}$

N4 = 466.67 rpm or 467 rpm

N4 = Driven Pulley rpm is 467.

So, pulley rpm = Blade stroke.

Therefore, Final Blade stroke is 467.

CHAPTER 09

ADVANTAGES, LIMITATION & APPLICATION

9.1 ADVANTAGES

- Power saving as compared to simple hacksaw.
- Time saving as it is manually operated.
- As it is pedal operated so good for health.
- Adjustable as it takes less room space.
- Blades are easy to change.
- It is portable. It could be used wherever metal or wood cutting is done in small scale, including at construction sites and furniture units, or to cut metal for windowpanes.

9.2 LIMITATIONS

- They are not capable of making straight cuts and moreover getting a straight cut using a scroll saw.
- Especially a longer, is nearly impossible.
- A scroll saw cannot handle cutting though different materials like metal.

9.3 APPLICATION

Scroll saws have a thin blade that allows you to cut intricate curves and corners.

- For advanced users, this means inlay work.
- Musical instruments.
- Dovetail joints & other types of joinery.

CHAPTER 10

OUR CONTRIBUTION

TO DESIGN CAPTURE

- Designing of major components of project.
- Selection of material for making project feasible.
- Economics project.
- All manufacturing process like, casting of pedal & pulleys , machining of wooden , chain & finishing assembling of thesis parts.
- Collect data of different pedal operated scroll saw includes weight, speeds.
- Output power calculation, and dynamic of the project.

CHAPTER 11

CONCLUSION & RECOMMANDATION

Thus a low cost and simple design pedal operated scroll saw is fabricated. This machine reduce the human effort and hence we need one person to cut the wooden small logs. This is simple design of conventional design which can enhance day today household needs and daily day to day purposes and it can be also used in for industrial applications during power shut down scenarios.

This project is made with pre planning, that is provides flexibility in operation. Smoother and easy handling operation for cutting any small wooden logs. This project is very much economical & helpful to production. By using this method we can do any operation as per our requirement without the use of electricity. So we can save the electrical power. Thus we are complete the project successfully.

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